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Final Report

for

ONR Contract N00014-88-K-0240
HIPAS 1987-88: ULF Research and Campaign Support

by

John V. Olson
Geophysical Institute
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I. HIPAS Campaign Support

Two HIPAS campaigns were conducted during the period from October 1, 1987 to September 30, 1989. The first campaign spanned the interval from October 12 to 24, 1988, the second from July 10 to 22, 1988, and the third was from July 5 through August 9, 1989. .

I.A. The October 1987 Campaign

During the October campaign several intervals were noted in which naturally occurring ULF signals were present during Dr. Ferraro's ELF heating experiments. A one-to-one correlation was found between the ULF and ELF polarization characteristics. ULF pulsations are the result of resonant hydromagnetic waves standing in the earth's magnetic field. They drive currents in the ionosphere, primarily at E region heights above 100 km. The heating experiment, which produced ELF returns, heated electrons below 100 km in the D region. The correlation led us to a series of studies of the causal link between the ULF and ELF signals. A preliminary analysis of the correlation has been submitted as a paper to the journal *Radio Science*. The title of the manuscript is **Observations of ULF Pulsation Electric Fields in the D Region Using the HIPAS Heater Facility** by J. V. Olson, A. J. Ferraro and H.-S. Lee.

A graduate student, Mr. A. Koivunen, at the University of Alaska began an analysis of the correlation by modelling the conductivity changes in the D region produced during heating. The analysis shows that there is sufficient increase in the electron conductivity produced in the D region by the HIPAS heater to allow the fringing electric field of the ULF pulsations to drive a detectable current.

I.B. The July 1988 Campaign

A second campaign was held during July 1988. In preparation for this campaign, two data acquisition systems were acquired and placed at two sites in Alaska to supplement the Alaska meridian chain of magnetometers. The first system was placed in Tok, Alaska and the second in Coldfoot, Alaska and both were operated continuously during the period of the campaign. These two sites give us measures of the magnetic fields, and hence the ionospheric currents over a two-dimensional region rather than the one dimensional estimate available using only the Alaska meridian chain.

No ULF signals were detected during the July campaign. The ionosphere was quiet during most of the period and so other experimental modes were explored including beam-steering and phase height experiments.

The July 1989 Campaign

The final campaign in this program was held from July 5 through August 9, 1989. During this period magnetospheric activity was low and the centroid of the polar electrojet lay north of the HIPAS heater facility. An extensive ELF program was conducted. There were no intervals of ULF activity. Two attempts were made to modulate the heater at frequencies below 10 hz. We used real-time spectral averaging techniques to search for the modulating signal at 6 hz but nothing was observed above the ambient background.

II. Other Work

During a program review held at ONR headquarters in Arlington, Va. on May 26, 1988 we reviewed our progress to that point and summarized our plans for the coming campaigns.

A final review was held at the HIPAS site on August 7, 1989. We presented an overview of the properties of the polar electrojet.

Finally, Mr. Alan C. Koivunen completed a Master's thesis in the Physics Department using support from this contract. His thesis was titled **Conductivity and Current Density Changes Due to RF Heating of the Lower Ionosohere** and a copy has been supplied to ONR under separate head.